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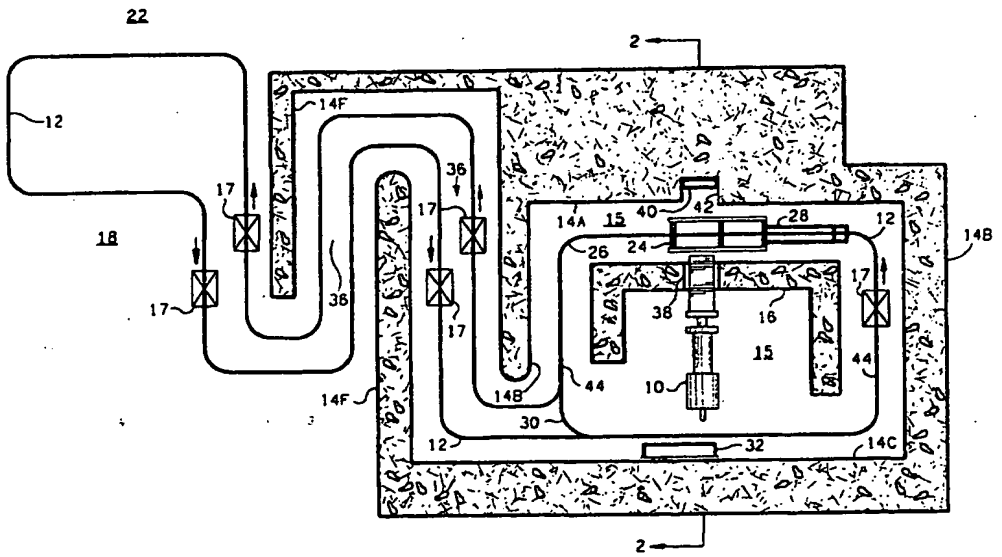
(54) Title: ARTICLE IRRADIATION SYSTEM HAVING INTERMEDIATE WALL OF RADIATION SHIELDING MATERIAL WITHIN LOOP OF A CONVEYOR SYSTEM THAT TRANSPORTS THE ARTICLES

(57) Abstract

An article irradiation system includes a radiation source (10) for scanning a target region (20) with radiation, a conveyor system (12) including a process conveyor (24) positioned for transporting articles in a given direction through the target region (20); radiation shielding material defining a chamber (15) containing the radiation source (10), the target region (20) and a portion of the conveyor system (12); wherein the radiation source (10) is disposed along an approximately horizontal axis inside a loop (26) defined by a portion of the conveyor system (12) and is adapted for scanning the articles being transported through the target region (20) with radiation scanned in a plane transverse to the given direction of transport by the process conveyor (24); and an intermediate wall (16) of radiation shielding material positioned within the loop (26) and transverse to the approximately horizontal axis. The intermediate wall (16) supports a ceiling of the chamber (15), inhibits photons emitted from a beam stop (40) disposed in a given wall (14A) from impinging upon at least one other wall (14C) of the chamber (15) and restricts flow throughout the chamber (15) of ozone derived in the target region (20) from the radiation source (10).



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ARTICLE IRRADIATION SYSTEM HAVING INTERMEDIATE WALL OF RADIATION SHIELDING MATERIAL WITHIN LOOP OF A CONVEYOR SYSTEM THAT TRANSPORTS THE ARTICLES

BACKGROUND OF THE INVENTION

The present invention generally pertains to irradiation systems that utilize a conveyor system for transporting articles through a target region scanned by radiation from a radiation source and is particularly directed to an improvement in positioning the radiation shielding material of the system.

A prior art irradiation system that utilizes a conveyor system for transporting articles through a target region is described in U.S. Patent No. 5,396,074 to Peck et al. In such prior art system, the radiation source and a portion of the conveyor system are disposed in a chamber defined by concrete walls, wherein such concrete walls and additional concrete walls defining an angled passageway into the chamber for the conveyor system shield loading and unloading areas located outside of the chamber from radiation derived from the radiation source.

SUMMARY OF THE INVENTION

The present invention provides an article irradiation system, comprising a radiation source positioned for scanning a target region with radiation; a conveyor system including a process conveyor positioned for transporting articles in a given direction through the target region; radiation shielding material defining a chamber containing the radiation source, the target region and a portion of the conveyor system; wherein the radiation source is disposed along an approximately horizontal axis inside a loop defined by a portion of the conveyor system and is adapted for scanning the articles being transported through the target region with radiation scanned in a plane transverse to the given direction of transport by the process conveyor; and an intermediate wall of radiation shielding material positioned within the loop and transverse to said approximately horizontal axis.

The intermediate wall supports a ceiling of the chamber, inhibits photons emitted from a beam stop disposed in a given wall of the chamber from impinging upon at least one other wall of the chamber and restricts flow throughout the chamber of ozone derived in

the target region from the radiation source.

Additional features of the present invention are described with reference to the detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a schematic top plan view of a preferred embodiment of an irradiation system according to the present invention.

FIG. 2 is a schematic sectional view of a portion of the irradiation system of FIG. 1 as taken along line 2-2 and further showing article carriers in positions other than as shown in FIG. 1.

DETAILED DESCRIPTION

Referring to FIGS. 1 and 2, a preferred embodiment of an irradiation system according to the present invention includes a radiation source 10, a conveyor system 12, radiation shielding material 14 defining a chamber 15 and an intermediate wall 16 of radiation shielding material. Articles carried by article carriers 17 are transported by the conveyor system 12 in a direction indicated by the arrows from a loading area 18 through a target region 20 to an unloading area 22. The conveyor system 12 includes a process conveyor 24 for transporting articles carried by the article carriers 17 in a given direction through the target region 20.

The radiation source 10 preferably is a 10-million-electron-volt linear accelerator having an electron accelerating wave guide that provides an electron beam for irradiating articles transported through the target region 20 by the conveyor system 12 The radiation source 10 is disposed along an approximately horizontal axis 25 inside a loop 26 defined by a portion of the conveyor system 12 and is adapted for scanning the articles being transported through the target region 20 with an electron beam at a given rate in a plane perpendicular to the given direction of transport by the conveyor system 12. The scanning height and the current of the electron beam are adjusted in accordance with the height and radiation absorption characteristics of the articles being scanned. The scanning of the articles by the electron beam is further controlled as described in the above-referenced U.S. Patent No. 5,396,074. The accelerator is located inside a removable shield and protected from ionizing

radiation and ozone by interior walls. In alternative embodiments, the radiation source scans the articles with a type of radiation other than an electron beam, such as X-rays.

The conveyor system 12 includes a power-and-free conveyor throughout and, in addition to the process conveyor 24, further includes a load conveyor 28, all three of which are independently powered. The power-and-free conveyor functions as a transport conveyor for transporting the article carriers 17 at a first given speed from the process conveyor 24 through the unloading area 22 and the loading area 18 to the load conveyor 28. The process conveyor 24 transports the articles carriers 17 through the target region 20 at a second given speed that is different than the first given speed at which the article carriers 17 are transported by the transport conveyor. The load conveyor 28 transports the article carriers 17 from the transport conveyor to the process conveyor 24 at a speed that is varied during such transport in such a manner that when the article carriers 17 are positioned on the process conveyor 24 there is a predetermined separation distance between adjacent positioned article carriers 17. When an article carriers 17 is positioned on the process conveyor 24, the load conveyor 28 is transporting the article carriers 17 at the speed of the processor conveyor 24. Such a conveyor system 12 and the operation thereof is described in detail in the above-referenced U.S. Patent No. 5,396,074.

In order to reorient articles for retransportation through the target region 20 so that such articles can be irradiated from opposite sides, upon it being detected that an article carrier 17 carrying such articles is so oriented as to have been transported through the target region 20 only once, such article carrier 17 is diverted onto a reroute conveyor section 30 and then transported by the transport conveyor past a mechanism 32 that reorients the so-oriented article carrier 17 by 180 degrees for said retransportation through the target region 20. Such a reorienting mechanism 32 and means for detecting the orientation of an article carrier 17 are also described in U.S. Patent No. 5,396,074 to Peck et al.

The radiation shielding material 14 includes walls 14A, 14B, 14C, a floor 14D and a ceiling 14E defining the chamber 15 that contains the radiation source 10, the target region 20 and at least the portion of the conveyor system 12 that includes the process conveyor 24, the load conveyor 28 and the adjacent portions of the transport conveyor. Additional walls 14F of radiation shielding material define an angled passageway 36 into the chamber 15 for the conveyor system 12 and shield the loading area 18 and the unloading area- 22, which are located outside of the chamber 15, from radiation derived from the radiation source 10.

The intermediate wall 16 is positioned within the loop 26 and transverse to the

approximately horizontal axis 25 of the radiation source 10. The intermediate wall 16 has an aperture 3 8 through which the radiation source 10 is disposed.

The ceiling section 14E of the radiation shielding material is supported in part by the intermediate wall 16; whereby the underlying chamber 15 may be of a greater area and/or the ceiling section 14E may of a greater span and/or of a greater weight than would be permitted in the absence of such support.

Preferably, the radiation shielding material 14A, 14B, 14C, 14D, 14E, 14F (collectively referred to as 14), 16 is primarily concrete because of cost considerations. However, other types of radiation shielding material may be used when space is limited or in view of other requirements, such as steel. In alternative embodiments, some of the radiation shielding material may be concrete and some not. For example, in one alternative embodiment, the intermediate wall 16 is a type of radiation shielding material other than concrete, such as steel, selected in accordance with limited space requirements, while the remainder of the radiation shielding material 14 is concrete.

A beam stop 40 is disposed in a recess 42 in the wall 14A of radiation shielding material that is on the opposite side of the target region 20 from the electron beam radiation source 10. The beam stop 40 is made of a material, such as aluminum, that absorbs electrons and converts the energy of the absorbed electrons into photons that are emitted from the beam stop 40. The beam stop 40 is so disposed in the recess 42 that some of the photons emitted from the beam stop 40 toward the radiation source 10 but obliquely thereto are inhibited from entering the chamber 15 by the portion of the radiation shielding material in the wall 14A that defines the recess 42. The recessing of the beam stop 40 reduces the intensity of back scattered photons, thereby decreasing the thickness required for the side walls 14B, the back wall 14C and the ceiling section 14E. This reduces construction costs and shortens the construction schedule.

Sections 44 of the transport conveyor portion of the conveyor system 12 are positioned for transporting the article carriers 17 in directions that are transverse to the given direction of transport by the process conveyor 24. The lateral walls 14B of the chamber-defining radiation shielding material are disposed outside the loop 26 ad adjacent the these transversely positioned sections 44 of the conveyor system 12 and portions of the intermediate wall 16 are positioned adjacent these transversely positioned sections 44 of the conveyor system 12 and across from substantial portions of the lateral walls 14A.

The intermediate wall 16 is thereby positioned between the beam stop 40 and the lateral walls 14B so that photons emitted into the chamber 15 from the beam stop 40 are inhibited from impinging upon the lateral walls 14B. The intermediate wall 16 is also positioned between the beam stop 40 and the wall 14C on the opposite side of the chamber 15 from the wall 14A in which the beam stop 40 is recessed so that photons emitted into the chamber 15 from the beam stop 40 are inhibited from impinging upon the opposite wall 14C. As a result, the lateral walls 14B and the opposite wall 14C may be of a lesser thickness of radiation shielding material than would be required in the absence of the intermediate wall 16.

The intermediate wall 16 also is positioned for restricting flow throughout the chamber 15 of ozone derived in the target region 20 from the radiation source 10. Accordingly, most of such ozone can be removed from the chamber 15 by exhaust ducts 46 in the chamber 15 disposed above the target region 20.

The dimensions of the various components of the radiation shielding material 14 and of the intermediate wall of radiation shielding material 16 are determined by computer-aided modeling in accordance a technique described in a manual entitled "MCNP - A General Monte Carlo Code for Neutron and Photon Transport" published by the Radiation Shielding Information Center, P.O. Box 2008, Oak Ridge, Tennessee 37831.

In an alternative embodiment, the loop within which the intermediate wall 14B is positioned is not a closed loop, such as shown in FIG. 1, but instead is an open loop, such as would be formed by elimination of the reroute conveyor section 30.

An article irradiation system in accordance with the present invention provides the advantages of: (a) reducing the volume of concrete required in the ceiling section 14E, thereby reducing the cost and complexity of the structure; (b) reducing radiation levels incident on sensitive electrical and mechanical equipment, such as the radiation source 10 and the reorienting mechanism 32, thereby prolonging the life of such equipment; and (c) constraining ozone production to the vicinity of the process conveyor 24, thereby reducing the quantity of ozone produced and its dispersal throughout the chamber 15 so as to prolong the life of the equipment and reduce the environmental impact of ozone vented to the atmosphere.

The advantages specifically stated herein do not necessarily apply to every conceivable embodiment of the present invention. Further, such stated advantages of the present invention are only examples and should not be construed as the only advantages of the present invention.

While the above description contains many specificities, these should not be construed as limitations on the scope of the present invention, but rather as examples of the preferred embodiments described herein. Other variations are possible and the scope of the present invention should be determined not by the embodiments described herein but rather by the claims and their legal equivalents.

CLAIMS

1. An article irradiation system, comprising

a radiation source positioned for scanning a target region with radiation;

a conveyor system including a process conveyor positioned for transporting articles in a given direction through the target region;

radiation shielding material defining a chamber containing the radiation source the target region and a portion of the conveyor system;

wherein the radiation source is disposed along an approximately horizontal axis inside a loop defined by a portion of the conveyor system and is adapted for scanning the articles being transported through the target region with radiation scanned in a plane transverse to the given direction of transport by the process conveyor; and

an intermediate wall of radiation shielding material positioned within the loop and transverse to said approximately horizontal axis.

2. A system according to Claim 1, wherein the intermediate wall has an aperture through which the radiation source is disposed.

3. A system according to Claim 1, wherein the chamber-defining radiation shielding material includes a ceiling section that is supported in part by the intermediate wall.

4. A system according to Claim 1, wherein the radiation source is an electron beam source, further comprising

a beam stop of material for absorbing electrons and for converting the energy of the absorbed electrons into photons that are emitted from the beam stop, wherein the beam stop is disposed on the opposite side of the target region from the radiation source;

wherein the beam stop is recessed within a portion of the chamber-defining radiation shielding material that is disposed on the opposite side of the target region from the radiation source so that some of the photons emitted from the beam stop toward the radiation source but obliquely thereto are inhibited from entering the chamber by said portion the radiation shielding material.

5. A system according to Claim 4, wherein a second portion of the conveyor system is positioned for transporting articles in a second direction that is transverse to the given direction of transport by the process conveyor;

wherein the chamber-defining radiation shielding material includes a lateral wall that is disposed outside the loop adjacent the second portion of the conveyor system; and

wherein the intermediate wall is positioned between the beam stop and the lateral wall so that photons emitted into the chamber from the beam stop are inhibited from impinging upon the lateral wall.

6. A system according to Claim 1, wherein a second portion of the conveyor system is positioned for transporting articles in a second direction that is transverse to the given direction of transport by the process conveyor;

wherein the chamber-defining radiation shielding material includes a lateral wall that is disposed outside the loop adjacent the second portion of the conveyor system; and

wherein a portion of the intermediate wall is adjacent the second portion of the conveyor system and across from a substantial portion of the lateral wall.

7. A system according to Claim 1, wherein the radiation source is an electron beam source, the system further comprising

a beam stop of material for absorbing electrons and for converting the energy of the absorbed electrons into photons that are emitted from the beam stop;

wherein the beam stop is disposed in a given wall of said chamber-defining radiation shielding material on the opposite side of the target region from the radiation source; and

wherein the intermediate wall is positioned between the beam stop and at least one other wall of said chamber-defining radiation shielding material so that photons emitted into the chamber from the beam stop are inhibited from impinging upon the at-least-one other wall.

8. A system according to Claim 1, wherein the intermediate wall is positioned for restricting flow throughout the chamber of ozone derived in the target region from the radiation source.

9. An irradiation system for irradiating articles, including:

a chamber defined by walls,

a radiation source constructed to provide radiation in the chamber,

a conveyor system constructed to carry the articles through the chamber for the reception of the radiation in the chamber by the articles,

first means disposed in the chamber for receiving radiation from the source and for converting the radiation to photons movable into the chamber, and

second means disposed in the chamber for inhibiting the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber.

10. An irradiation system as set forth in claim 9 wherein

the second means is disposed in the chamber to minimize the intensity of the photons.

11. An irradiation system as set forth in claim 9

wherein the radiation source extends through the second means.

12. An irradiation system as set forth in claim 9 wherein

the chamber includes a ceiling and wherein

the second means supports the ceiling.

13. An irradiation system as set forth in claim 10 wherein

the radiation source extends through the second means,

the chamber includes a ceiling and wherein

the second means supports the ceiling.

14. An irradiation system as set forth in claim 13 wherein

the second means includes an intermediate wall made from a radiation shielding material and wherein the radiation shielding material is separated from the walls of the chamber.

15. An irradiation system for irradiating articles, including,

a chamber defined by walls,

a radiation source constructed to provide radiation in the chamber,

a conveyor system constructed to carry the articles through the chamber for the reception of the radiation in the chamber by the articles,

ozone being derived in the chamber from the radiation source, and

means disposed in the chamber for restricting the flow of the ozone through the chamber.

16. An irradiation system as set forth in claim 15, including,

means disposed in the chamber for removing the ozone from the chamber.

17. An irradiation system as set forth in claim 15 wherein

the radiation source extends through the means for restricting the flow of the ozone through the chamber.

18. An irradiation system as set forth in claim 15 wherein

the walls of the chamber are made from a radiation shielding material.

19. An irradiation system as set forth in claim 15 wherein

the flow-restricting means constitutes a first means and wherein

second means are disposed in the chamber for receiving radiation from the source and for converting the radiation to photons in the chamber and wherein

the first means inhibits the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber.

20. An irradiation system as set forth in claim 16 wherein

the flow-restricting means includes a wall disposed at an intermediate position in the chamber and separated from the walls defining the chamber and made from a radiation shielding material.

21. An irradiation system as set forth in claim 16 wherein

the chamber includes a ceiling and wherein

the flow-restricting means supports the ceiling.

22. An irradiation system as set forth in claim 20 wherein

the radiation source extends through the means for restricting the flow of the ozone through the chamber and wherein

the walls of the chamber are made from a radiation shielding material and wherein

the flow-restricting means constitutes a first means and wherein

second means are disposed in the chamber for receiving radiation from the source and for converting the radiation to photons in the chamber and wherein

the first means inhibits the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber and wherein

the chamber includes a ceiling and wherein

the flow-restricting means supports the ceiling.

23. An irradiation system for irradiating articles, including,

a chamber defined by walls,

a radiation source constructed to provide radiation in the chamber,

a conveyor system constructed to carry the articles through the chamber for the reception by the articles of radiation in the chamber,

a beam stop disposed in the chamber for absorbing electrons from the radiation source and for converting energy from the absorbed electrons into photons and for emitting the photons, and

the beam stop being disposed relative to a particular one of the walls of the chamber to provide for the reduction in the intensity of the photons in the chamber by the particular one of the walls, and

means disposed in the chamber for inhibiting the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber.

24. An irradiation system as set forth in claim 17 wherein

the beam stop is recessed in the particular one of the walls of the chamber to

provide for the redirection of the intensity of the photons in the chamber by the particular one of the walls and wherein

the inhibiting means includes an additional wall disposed intermediate the walls defining the chamber and separated from the walls defining the chamber for inhibiting the photons from impinging on the walls defining the chamber, thereby providing for the reduction in the thickness of the walls defining the chamber.

25. An irradiation system as set forth in claim 24 wherein the walls defining the chamber and the additional wall are made from a radiation shielding material.

26. An irradiation system as set forth in claim 25 wherein

a ceiling is provided and is made from a radiation shielding material and wherein

the additional wall supports the ceiling.

27. An irradiation system for irradiating articles, including,

a chamber defined by walls,

a radiation source constructed to provide radiation in the chamber,

a conveyor system constructed to carry the articles through the chamber for the reception by the articles of radiation in the chamber,

a beam stop disposed in the chamber for absorbing electrons from the radiation source and for converting energy of the absorbed electrons into photons and for emitting the photons, and

the beam stop being disposed relative to a particular one of the walls of the chamber to provide for a reduction in the intensity of the photons in the chamber by the particular one of the walls,

means disposed in the chamber for inhibiting the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber,

ozone being derived in the chamber from the radiation source, and

the photon-inhibiting means being operative to restrict the flow of ozone through the chamber.

28. An irradiation system as set forth in claim 27 wherein

the photon-inhibiting means includes an intermediate wall disposed in the chamber in spaced relationship to the walls defining the chamber.

29. An irradiation system as set forth in claim 28 wherein

the intermediate wall and the walls defining the chamber are made from a radiation shielding material.

30. An irradiation system for irradiating articles, including,

a chamber defined by walls,

a radiation source disposed to provide radiation,

a loading area for the articles,

an unloading area for the articles,

a conveyor system constructed to move the articles through the chamber in a loop,

a first path extending from the loading area to the loop through the chamber,

a second path extending from the loop through the chamber to the unloading area,

the first and second paths being disposed in adjacent relationship to each other and in communicating relationship with the chamber and being separated from the chamber for at least a portion of their lengths by a particular one of the walls defining the chamber, and

an additional wall disposed outside of the chamber,

the first and second paths being confined between the particular wall and the additional wall.

31. An irradiation system as set forth in claim 30 wherein

the walls defining the chamber and the additional wall are made from a radiation shielding material.

32. An irradiation system as set forth in claim 31 wherein

the particular wall and the additional wall are disposed relative to the loading area and the unloading are to prevent radiation from the source from reaching the loading area and the unloading area.

33. An irradiation system as set forth in claim 32 wherein

the particular wall has a limited length to provide for a communication between the chamber and each of the first and second paths.

34. An irradiation system as set forth in claim 31, including,

means disposed in the chamber for receiving radiation from the source and for converting the radiation to photons movable into the chamber, and

means disposed in the chamber for inhibiting the photons from impinging on the walls defining the chamber, thereby providing for a reduction in the thickness of the walls defining the chamber.

35. An irradiation system as set forth in claim 32, including,

ozone being derived in the chamber from the radiation source, and

means disposed in the chamber for restricting the flow of ozone through the chamber.

36. An irradiation system as set forth in claim 34 wherein

the particular wall and the additional wall are disposed relative to the loading area and the unloading area to prevent radiation from the source from reaching the loading area and the unloading area and wherein

the particular wall has a limited length to provide for a communication between the chamber and each of the first and second paths and wherein

ozone is derived in the chamber from the radiation source and wherein

means are disposed in the chamber for restricting the flow of ozone through the chamber.

37. A method of providing an irradiation of articles, including the steps of:

providing a chamber defined by a plurality of walls,

providing a loading area for the articles at a position displaced from the chamber,

providing an unloading area for the articles at a position displaced from the chamber,

providing a source of radiation in the chamber, the source having properties of

producing photons in the chamber,

providing a conveyor path for the movement of the articles from the loading area through the chamber to the unloading area and for the irradiation of the articles by the source during the movement of the articles through the chamber, and

providing a member in the chamber for inhibiting the movement of the photons to the walls defining the chamber, thereby minimizing the thickness of the walls.

38. A method as set forth in claim 37 wherein

the member is an intermediate wall disposed in the chamber in separated relationship to the walls defining the chamber.

39. A method as set forth in claim 38 wherein

the walls in the plurality and the member are formed from a radiation shielding material.

40. A method as set forth in claim 38 wherein

a first path extends from the loading area to the chamber and wherein

a second path extends from the unloading area to the chamber in adjacent relationship to the first path and wherein

an additional wall is disposed outside of the chamber in cooperative relationship with a particular one of the walls defining the chamber to define a confining relationship for the first and second paths.

41. A method as set forth in claim 40 wherein

the walls defining the chamber and the member and the additional wall are made from a radiation shielding material.

42. A method as set forth in claim 41 wherein

the particular one of the walls defining the chamber is provided with a limited length to provide for a communication of the first and second paths with the chamber.

43. A method of providing an irradiation of articles, including the steps of:

providing a chamber defined by a plurality of walls,

providing a conveyor path for the movement of the articles through the chamber and for the irradiation of the articles by the source during the movement of the articles through the chamber,

providing a loading area for the articles at a position displaced from the chamber,

providing an unloading area for the articles at a position displaced from the chamber,

providing a source of radiation in the chamber, the source having properties of deriving ozone in the chamber, and

providing a member in the chamber for restricting the flow of the ozone in the chamber.

44. A method as set forth in claim 43 wherein

the member is an intermediate wall disposed in the chamber in spaced relationship to the walls defining the chamber.

45. A method as set forth in claim 44 wherein

the additional wall and the walls defining the chamber are made from a radiation shielding material.

46. A method as set forth in claim 45 wherein

a first path extends from the loading area to the chamber and wherein

a second path extends from the unloading area to the chamber in adjacent relationship to the first path and wherein an additional wall is disposed outside of the chamber in cooperative relationship with a particular one of the walls defining the chamber to define a confining relationship with the first and second paths.

47. A method as set forth in claim 46 wherein

the particular one of the walls defining the chamber is provided with a length to define for a communication of the first and second paths with the chamber.

48. A method of providing an irradiation of articles, including the steps of:

providing a chamber defined by a plurality of walls,

providing a conveyor path for the movement of the articles through the chamber and for the irradiation of the articles by the source during the movement of the articles through the chamber,

providing a loading area for the articles at a position displaced form the chamber,

providing an unloading area for the articles at a position displaced from the chamber,

providing a first path from the loading area to the chamber,

providing a second path from the chamber to the unloading area in adjacent relationship to the first path, and

the first and second paths being disposed in adjacent relationship to a particular one of the walls defining the chamber, and

providing an additional wall on an opposite side of the first and second paths from the particular wall.

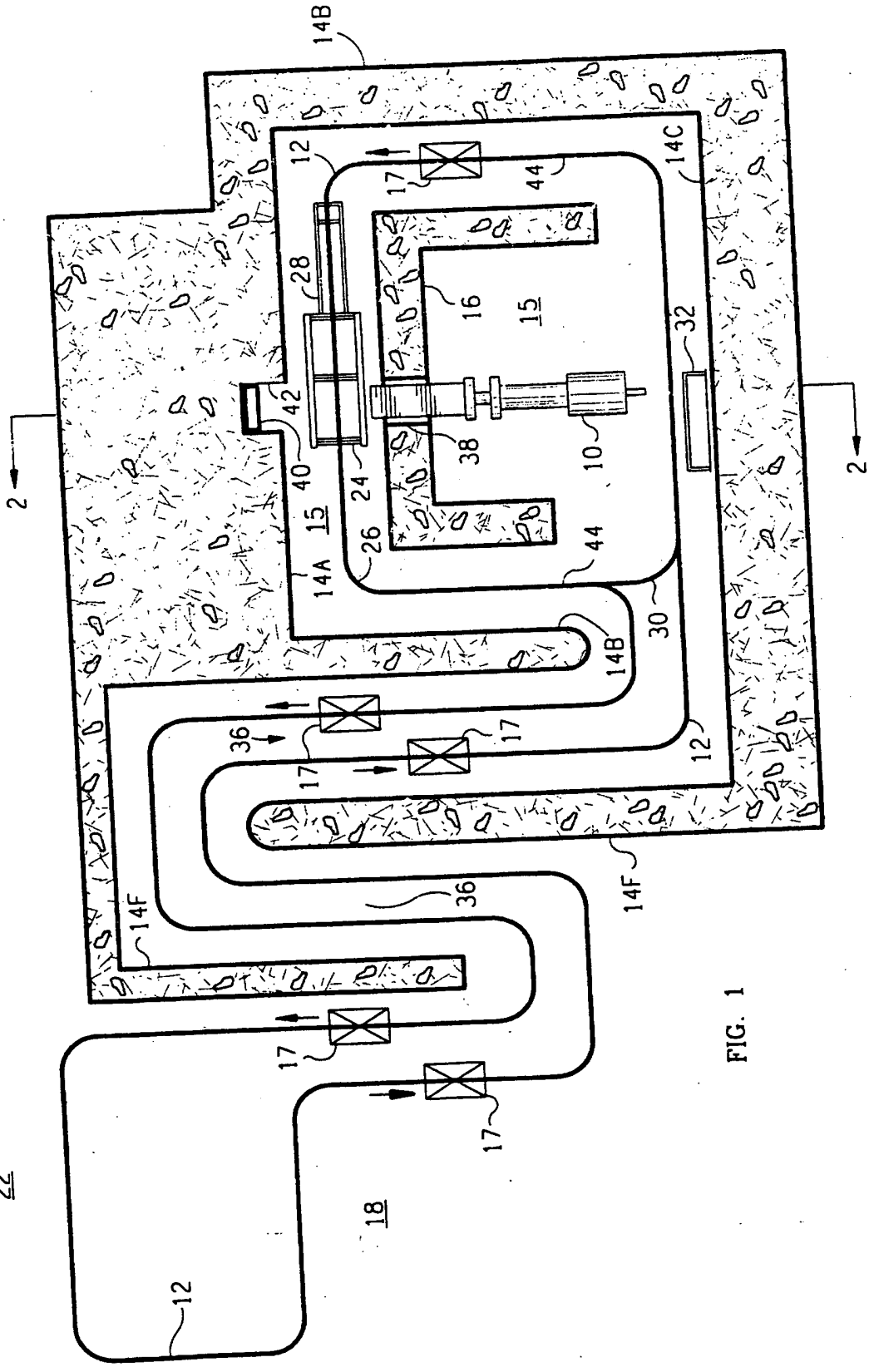
49. A method as set forth in claim 48 wherein

the walls defining the chamber and the additional wall are made from a radiation shielding material.

50. A method as set forth in claim 49 wherein

the first and second paths are substantially parallel and are contiguous and wherein

the particular wall and the additional wall are substantially parallel to each other and to the first and second paths and are respectively contiguous to the first and second paths on opposite sides of the first and second paths.


14B
12
17
44
14C
28
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14A
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14B
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14F
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14F
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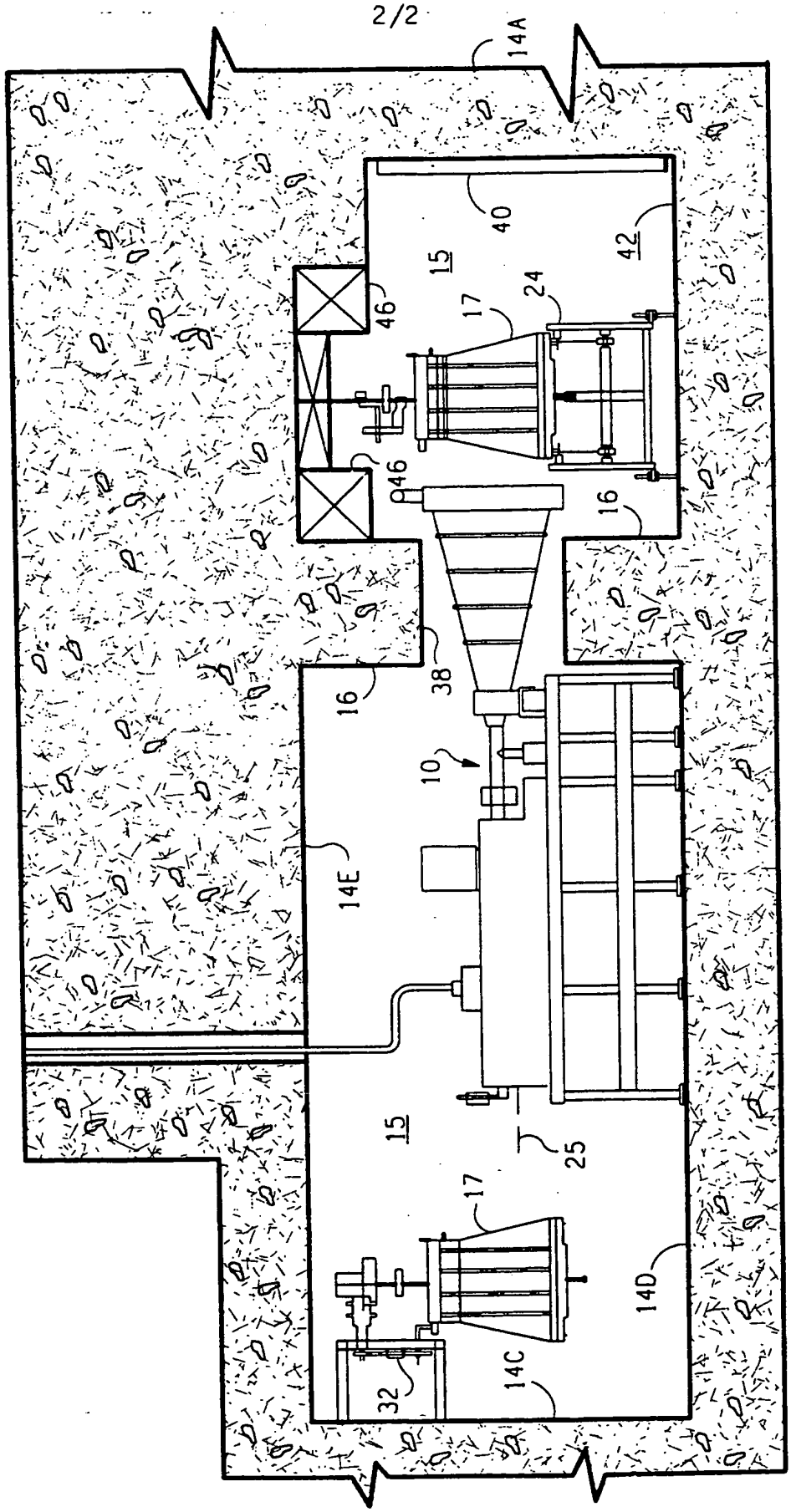
FIG. 1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/13437

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G21K 1/00
US CL : 250/492.3, 455.11, 517.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 250/492.3, 455.11, 517.1, 453.11, 454.11

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,345,545 A (MILLER) 24 August 1982 (24/08/82), whole document, especially Figures 2 and 3.	1-3, 6-14, 23, 27-29 --- 20-22, 37-42, 44-47
X --- Y	US 4,446,374 A (IVANOV et al) 01 May 1984 01/05/84), whole document, especially col. 1, line 57, through col. 2, line 9, and col. 4, lines 21-26.	15-19 --- 20-22, 34-36, 43-47
X ---- Y	US 4,852,138 A (BERGERET et al) 25 July 1989, (25/07/89), see figures 2 and 3.	30-33 --- 34-47

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search
18 AUGUST 1999

Date of mailing of the international search report
29 OCT 1999

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/13437

B x I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 24-26 and 48
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Please See Extra Sheet.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US99/13437

BOX I. OBSERVATIONS WHERE CLAIMS WERE FOUND UNSEARCHABLE

2. Where no meaningful search could be carried out, specifically:

There is no antecedent basis for "the beam stop" in claim 24. It looks like this claim was intended to depend from claim 23, not claim 17 as it is written. Claim 48 ends abruptly after "a plurality of walls," in line 2. It looks like the claim was intended to continue on another page, but no such page was included. (The examiner notes that there are 10 pages of claims in the application, not 11 as indicated on sheet 5 of Form PCT/RO/101.)

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(74) Agents: PARKHURST, David, G. et al.; Fulwider Patton Lee & Utecht, LLP, 10th floor, 10877 Wilshire Boulevard, Los Angeles, CA 90024 (US).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published

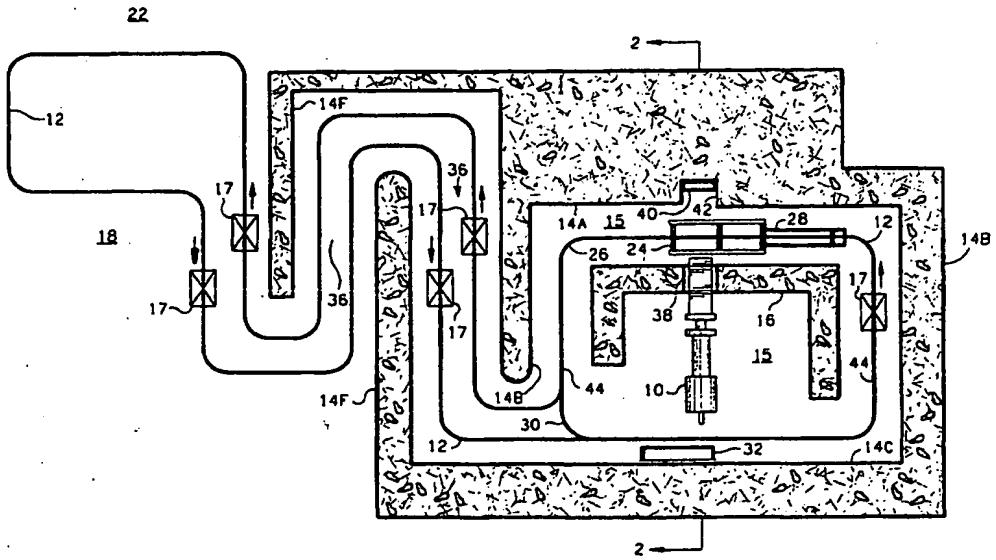
With a revised version of the international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(88) Date of publication of the revised version of the international search report: 30 March 2000 (30.03.00)

(54) Title: ARTICLE IRRADIATION SYSTEM HAVING INTERMEDIATE WALL OF RADIATION SHIELDING MATERIAL WITHIN LOOP OF A CONVEYOR SYSTEM THAT TRANSPORTS THE ARTICLES

(57) Abstract

An article irradiation system includes a radiation source (10) for scanning a target region (20) with radiation, a conveyor system (12) including a process conveyor (24) positioned for transporting articles in a given direction through the target region (20); radiation shielding material defining a chamber (15) containing the radiation source (10), the target region (20) and a portion of the conveyor system (12); wherein the radiation source (10) is disposed along an approximately horizontal axis inside a loop (26) defined by a portion of the conveyor system (12) and is adapted for scanning the articles being transported through the target region (20) with radiation scanned in a plane transverse to the given direction of transport by the process conveyor (24); and an intermediate wall (16) of radiation shielding material positioned within the loop (26) and transverse to the appr ximately horizontal axis. The intermediate wall (16) supports a ceiling of the chamber (15), inhibits photons emitted from a beam stop (40) disposed in a given wall (14A) from impinging upon at least one other wall (14C) of the chamber (15) and restricts flow throughout the chamber (15) of ozone derived in the target region (20) from the radiation source (10).



*(Referred to in PCT Gazette No. 13/2000, Section II)

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ZW	Zimbabwe

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"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 27 JANUARY 2000	Date of mailing of the international search report 11 FEB 2000
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Form PCT/ISA/210 (second sheet)(July 1992)*